PART NO. 0112-0100

FEBRUARY 15, 1979

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MODEL K100-D
DIGITAL LOGIC ANALYZER

OPERATING AND SERVICE MANUAL

PRELIMINARY

Gould Inc., Biomation Division 4600 Old Ironsides Drive, Santa Clara, CA 95050
(408) 988-6800 TWX: 910-338-0509 Printed in U.S.A.

GOULD

OPERATING AND SERVICE MANUAL

MODEL K100-D

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SECTION I

GENERAL INFORMATION

1.1 Certification

Gould Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory.

1.2 Warranty

All Gould Inc. products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products that prove to be defective during the warranty period. If a unit fails within thirty days of delivery, Gould Inc. will pay all shipping charges relating to the repair of the unit. Units under warranty, but beyond the thirty day period, should be sent to Gould Inc. prepaid and Gould Inc. will return the unit prepaid. Units out of the one year warranty period, the customer will pay all freight charges. IN THE EVENT OF A BREACH OF GOULD INC.'S WARRANTY, GOULD INC. SHALL HAVE THE RIGHT IN ITS DISCRETION EITHER TO REPLACE OR REPAIR THE DEFECTIVE GOODS OR TO REFUND THE PORTION OF THE PURCHASE PRICE APPLICABLE THERETO. THERE SHALL BE NO OTHER REMEDY FOR BREACH OF THE WARRANTY. IN NO EVENT SHALL GOULD INC. BE LIABLE FOR THE COST OF PROCESSING, LOST PROFITS, INJURY TO GOODWILL, OR ANY SPECIAL OR CONSEQUENTIAL DAMAGES. THE FOREGOING WARRANTY IS EXCLUSIVE OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

1.3 Description

The Model K100-D Logic Analyzer was designed to provide the utmost in performance and versatility for the digital designer and troubleshooter. It serves as both a time domain (data recorded asynchronously), and a data domain analysis tool (data recorded synchronously). The unit accepts up to 16 logic signals through its active input probes, and stores these discriminated signals in its 1024 word memory, at sample rates to 100 MHz. The unit is depicted in Figure 1.1.

The Model K100-D has comprehensive recording and display analysis capabilities that enable the user to perform complex timing and state analysis of his digital systems. The unit has three distinct features that make it a useful tool for logic troubleshooting.

First, the signals from the user's system are input via specially designed hybrid active probes. The input impedance of each probe is 1 MΩ, 5 pF. The probes are individual to allow spanning to physically separated points in the system, and also to provide for convenient connection at the PC board level. Signal conditioning, or threshold detection, and buffering of a particular signal is provided at a point as close as possible to the user's circuitry. The probe tip, with its accessories, allows convenient connection to a system. The probes detect logic spikes or glitches down to 5 ns regardless of clock rate used.

Second, the instrument can clock at rates to 100 MHz, allowing timing measurements on up to 16 signals, with a 10 ns time resolution. A relatively long memory, 1024 words, allows precise timing measurements over longer intervals of time. The performance of the active probes complement this high-speed recording capability.

Third, the instrument uses a microprocessor linked to a front keyboard for instrument control. Comprehensive display prompting is used to make it easy to set up the unit for desired recording and display formats. This gives a greater degree of flexibility in recording and display functions than was possible with earlier instruments.

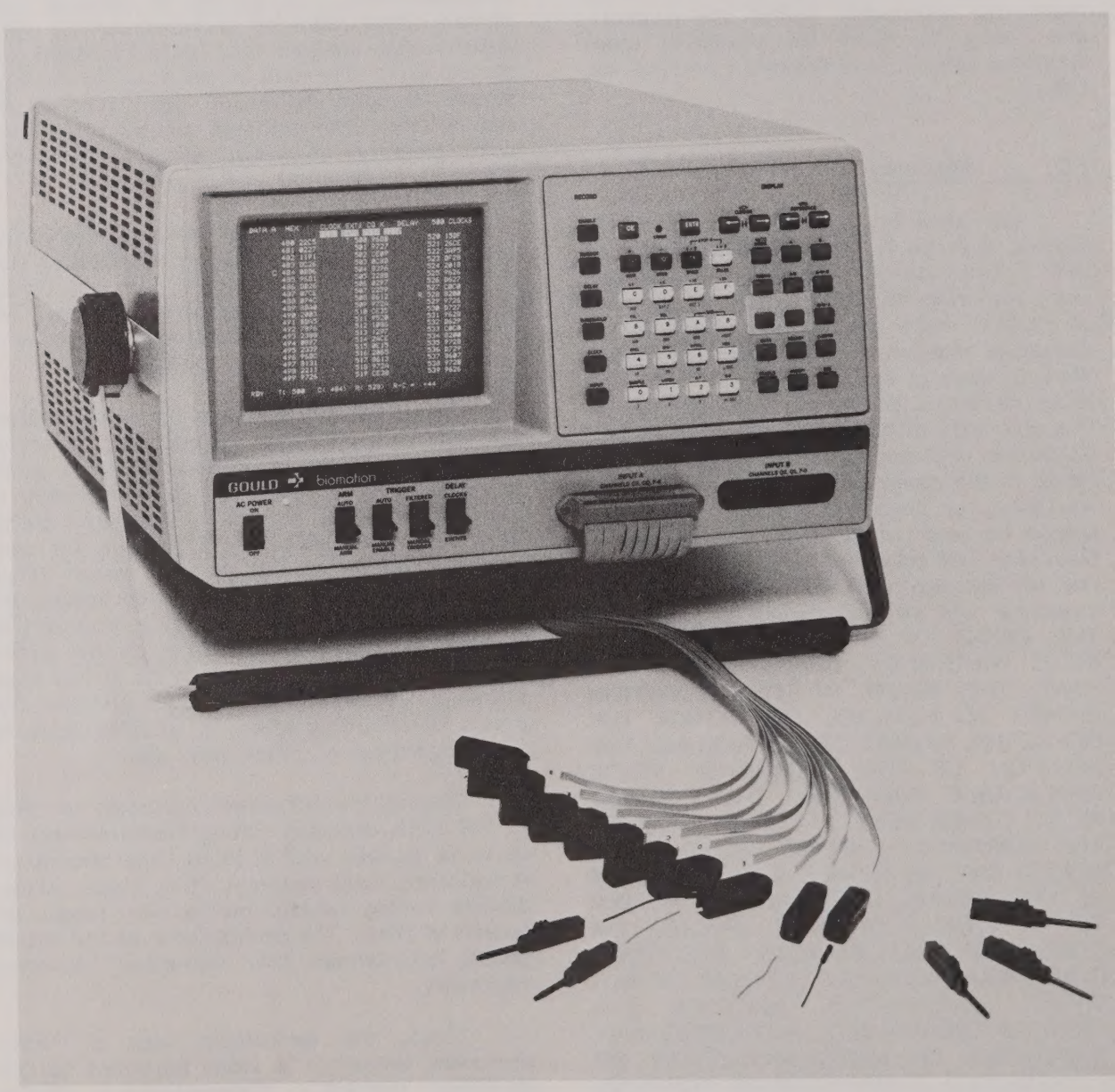


Figure 1.1 The Model K100-D with its high performance active probes.

1.4 Specifications

SIGNAL INPUTS

Number. 20, including 16 data, external clock and qualifier, and 2 trigger qualifiers.

Impedance. 1 MΩ, 5 pF, over input range of ±10 V.

Threshold. Each input may be assigned one of four references: TTL (+1.4 V), ECL (-1.3 V), VAR A, VAR B; A & B selectable between -6.4 V and +6.35 V, in 50 mV increments. Thresholds are referenced to probe tip. High or low true logic polarity selectable each channel.

Maximum Voltage. ±50 V continuous, ±100 V transient.

Modes. Each data input selectable Sample or Latch.

SAMPLE. Unit stores the detected logic level present at each active clock transition simultaneously on all inputs. Minimum pulse always detected and stored is one clock period plus 4 ns.

SKEW. Channel to channel, 1 ns typical.

LATCH. Whenever an even number of threshold transitions occur between two successive clock intervals, an input latch stores the state opposite that stored at the previous clock interval on the next clock. The glitch may be stored in one or two memory cells.

MINIMUM DETECTABLE PULSE. 5 ns with threshold overdrive of 25% of total voltage swing, or 250 mV, whichever is greater.

CLOCK

Internal. Selectable from 10 ns (100 MHz) to 50 ms (20 Hz) in a 1-2-5 sequence.

External. Selectable positive or negative edge active, DC-70 MHz rate. Minimum pulse width 5 ns.

SETUP TIME. Data must be present 2 ns before clock active edge.

HOLD TIME. Data must be present 2 ns after active edge.

QUALIFIER. Must go TRUE a minimum of 12 ns before the clock goes TRUE, and go FALSE a minimum of 1 ns after clock goes TRUE; must go FALSE a minimum of 10 ns before clock goes FALSE. See Figure 1.2.

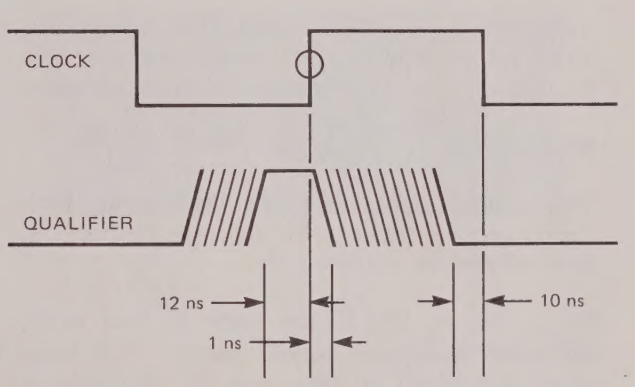


Figure 1.2 K100-D Clock Qualifier.

TRIGGER

Three events control data recording: Arm, Enable and Trigger.

Arm. Selectable Manual (front panel switch), Auto, Auto Stop, Auto Stop with limits.

Enable. Selectable Auto, Manual or Combinational. When Combinational selected, unit will seek a defined word. Once detected, unit will seek the Trigger.

Trigger. Selectable Manual or Combinational. When Combinational selected, unit will seek a defined word. Once detected, unit will execute the trigger delay selected, and stop recording.

Qualifiers. Q1 and Q2 may be applied to

Enable, Trigger, both to each, or one to each.

Pattern Select. Enable and Trigger events may each be specified as an 18 bit word. Unit accepts binary (1, 0, X-don't care), as well as hexadecimal input. Can be selected for a GO TRUE or GO FALSE condition.

Delay. Trigger delay selectable clock intervals or Trigger occurrences (or events) to 65, 530. Delay by clocks is always measured between Trigger event and end of memory. When delaying by events, the nth + 1 event occupies memory location 501.

Filter. Selectable from 1 to 14 clock samples. Enable and Trigger must remain TRUE for the selected number of samples before being recognized.

Trigger Output. Rear panel BNC connector, TTL active high signal when unit detects trigger event. Synchronous with input data.

MEMORY

The K100-D contains three memories: high speed record memory M, storage memory A, and reference memory B.

Size. M, A, and B are each 16 bits wide, 1024 words long.

Use. M accepts new data, and automatically transfers it to A for display. B may be loaded through A, and is used as a reference.

Auto Stop. The unit Arms itself and acquires new data in A, which is compared with the contents of B.

Whenever conditions are met, any further recording is prevented. This allows comparison between the contents of A and B. Conditions may be A=B, or A≠B.

Comparison may be made over entire 1024 words, or may be limited to the data that lies between the positions of Cursor and Reference, inclusive. Also, only those channels displayed participate in the comparison.

Search. Via Status display, the unit accepts a 16 bit word for which it will search in memory A and/or B. All occurrences are marked by an asterisk. First and last occurrence, and total number of occurrences, are tabulated in Data display.

DISPLAY

Status, Timing, and Data domain displays are via built-in raster scan CRT. User control over order in which channels are displayed.

Status. Permits keyboard selection of recording and display parameters. Each parameter field (reverse video entry) is randomly addressable.

Timing. 16 channel format. Horizontal expansion X5, X10, X20. Vertical expansion X2, X4, via deleting channels. Cursor and Reference permit direct time measurements when using internal clock. Binary readout of data at Cursor or Reference position. Trigger event, if in memory, is marked.

Data. Selectable binary, hexadecimal, octal, or Special display. Decoding depends on user selection of channel order. In Special display, channel grouping permits decoding of data in binary, hexadecimal, octal, or ASCII, or any combination.

Video Output. BNC rear panel connector provides composite video output, 1 V pp into 75 Ω.

MISCELLANEOUS

Size. 21.8 cm (8.6 in) high; 44.6 cm (17.5 in) wide (with bail); 54.5 cm (18.9 in) deep (with bail).

Weight. 19.5 kg (43 lbs), including probes.

Power. 100, 120, 220 or 240 V RMS, ±10%; 400 W.

Temperature Range. 0-50°C, operating.

Warranty. All Gould/Biomation products are warranted against defects in materials and workmanship for one year from date of delivery.

Accessories. Each unit is supplied with a set of input probes (20 inputs) with probe leads and spring hook tips, power cord, and one Operating and Service Manual. Probes are available in 1.2 m (4 ft) or 1.8 m (6 ft) length.

SECTION II

INSTALLATION

2.1 Introduction

This section contains information on unpacking, inspection, repacking, storage, and installation of the Model K100-D.

2.2 Unpacking and Inspection

Inspect instrument for shipping damage as soon as it is unpacked. Check for broken knobs and connectors; inspect cabinet and panel surfaces for dents and scratches. If the instrument is damaged in any way or fails to operate properly, notify the carrier immediately. For assistance of any kind, including help with instruments under warranty, contact your local Gould Inc., Biomation Division, representative or Gould Inc., Biomation Division, in Santa Clara, California, U.S.A.

2.3 Storage and Shipment

To protect valuable electronic equipment during storage or shipment, always use the best packaging methods available. Contract packaging companies in many cities can provide dependable custom packaging on short notice.

2.4 Power Connection

The K100-D may be used on a wide range of power line voltages at frequencies of 50 or 60 Hz nominal. The rear panel contains a fuse holder and a pair of slide switches for selection of nominal power line voltages. Table 2.1 lists these voltages, switch positions, and fuse selection required for that power line voltage. The selected switch positions are referred to as left and right when viewed facing the rear panel.

Table 2.1 Line Voltage/Fuse Selection. Range shown is for 50-60 Hz line frequency.

Range (+10%)	Selector Switch Positions	Fuse-Amp (Slow Blow 3AG)
100	Both in	5
120	Left in, right out	5
220	Left out, right in	2.5
240	Left out, right out	2.5

Figure 2.1 illustrates the power input grouping (voltage change, fuse, and input connector).

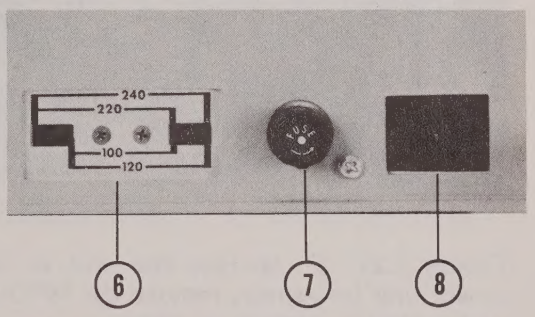


Figure 2.1. Power input grouping. Position the switches (6) as noted in Table 2.1, using the proper fuse.

In addition to selecting the proper line voltage, you must also place a jumper on the MPU printed circuit board, as shown in Figure 2.2, if you operate the unit on 50 Hz line frequency. This changes the refresh rate of the raster scan display to 50 Hz. Operation at 50 Hz may require minor adjustment of R2, the horizontal oscillator frequency control. See Appendix A.

2.5 Preparation for Use

The Model K100-D is entirely self contained with a built-in display and integral probe assemblies. All that is required is to connect the instrument to the line power and plug the probe assemblies into the front panel. The unit automatically senses whether it has

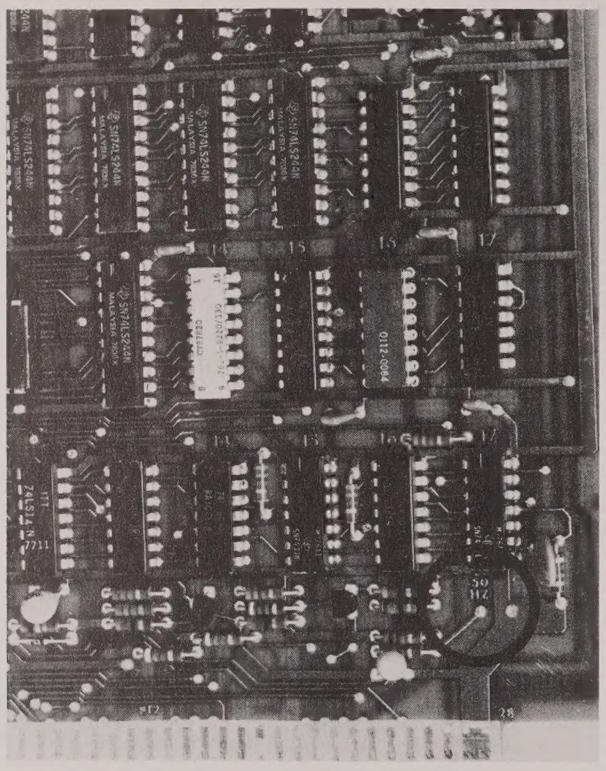


Figure 2.2. To operate the unit on 50 Hz power line frequency, remove the MPU board and install a jumper as shown.

the 16-channel probe assembly or the optional Model K100-D/32 Input Adapter. The status display mode thus displayed is a reflection of the respective input configuration.

When the K100-D is first turned on, it self-programs, allowing you to connect your probes and collect data from your system. Once the data has been collected, you may easily modify the data collection or display to suit your requirements. This operation enhances the self-teaching ability of the instrument, so you can quickly learn how to operate it. For details, refer to Section III Operation.

2.6 Initial Warm-up

Although the Model K100-D is a solid-state instrument, a brief warm-up period of approximately 10 minutes is required for the internal circuitry to reach thermal stability.

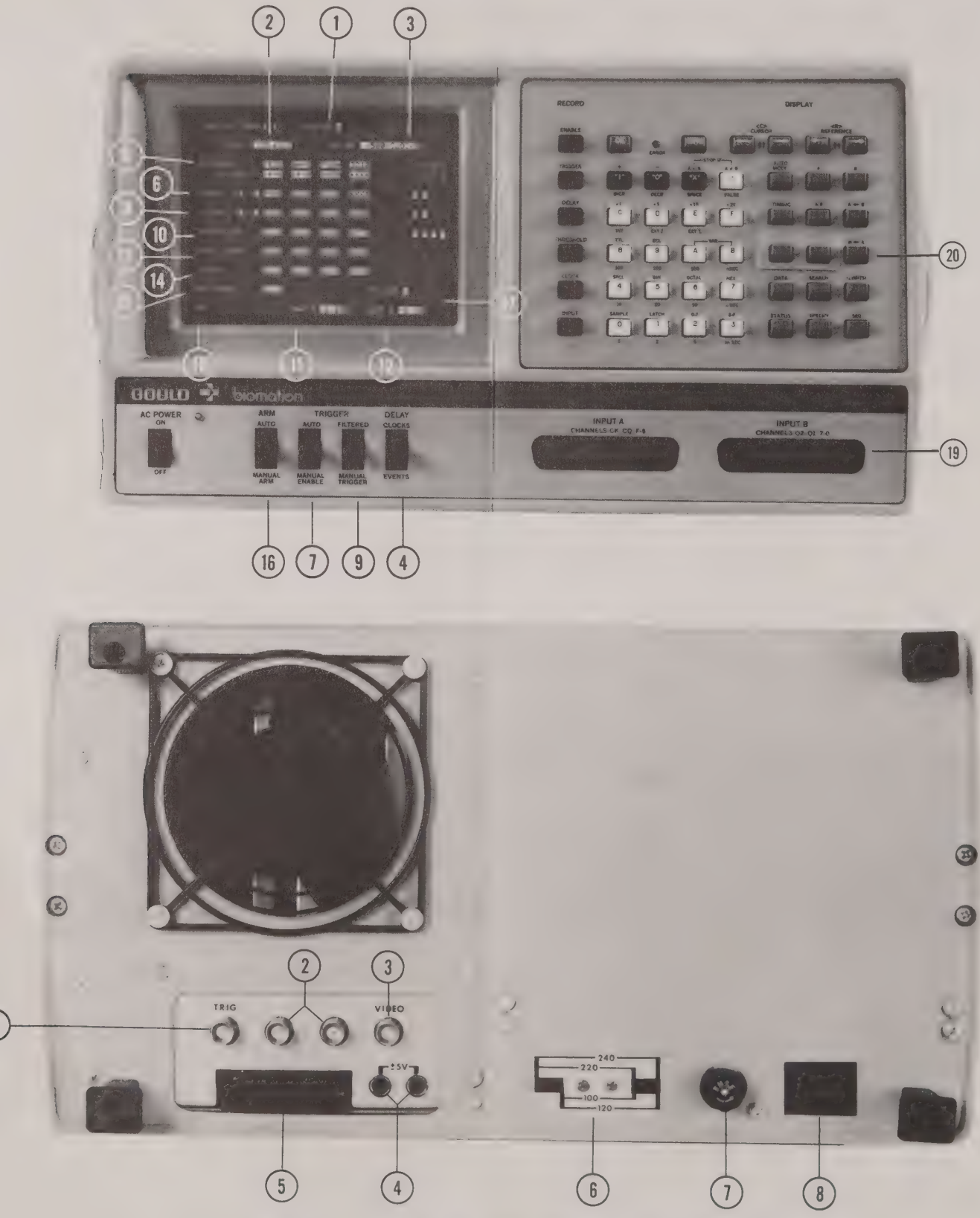


Figure 3.1 Front and rear panels of the K100-D.

SECTION III

OPERATION

3.1 Introduction

This section explains the use and function of the front panel controls and inputs, as well as the rear panel outputs. It also offers you a step-by-step procedure for operating the unit.

3.2 Front Panel Controls and Inputs

Refer to Figure 3.1 while reviewing this section.

The Model K100-D uses a keyboard entry system and interactive display for control of recording and display parameters. The arrangement of this control subsystem was designed to help you learn quickly and easily the effect of various keys, and the proper use of the features available in the instrument. It does this through the use of the Status display mode, shown in Figure 3.1.

When you first power up the K100-D, it goes through a detailed self-diagnostic test, wherein it checks its keyboard and memories. A detailed explanation of the test and its error indications are found in Appendix B. If the instrument indicates any errors in the power up self test, the source of the error may be diagnosed down to the IC package level using the diagnostic routine. The unit also loads part of its' own program into display memory. This allows you to practice specifying display parameters without having to record data.

Once self test is complete, the instrument sets itself into a default condition, as shown in the Status display in Figure 3.1.

Two default parameters can be user specified. There is a DIP switch on the Record Control board; you may cause the power up threshold condition to be either TTL or ECL. In addition, you may select Internal Clock or External Clock Rising Edge Active.

PARAMETER FIELDS

Each reverse video (bright box) entry in the Status mode denotes a "parameter field." Any one of these parameter fields may be randomly addressed and modified. Use the column of black keys on the left edge of the display to access any one of these parameter fields. In addition to the column of black keys, the blue keys labeled SEQ (Sequence) and SEARCH are used in the same fashion to access those respective parameter fields. There are also four momentary toggle switches on the lower front panel that access various parameter fields.

The operation of all keys and switches are covered below.

(1) STATUS W, A, B

STATUS W is the Status display mode shown on the CRT when any parameter field has been addressed or changed. This denotes that you are intending to make a subsequent measurement with different parameters from those used for the last measurement. Once a parameter field has been changed, and a new measurement (or recording) is made, STATUS W becomes STATUS A.

STATUS A indicates the parameter fields that were used to record and display information that is stored in Memory A. STATUS A display cannot be changed before a measurement has been made.

STATUS B refers to the data stored in Memory B. It is a mnemonic for the data stored, and cannot be changed except by changing the data stored in Memory B. This is done by loading new data into A and transferring to B.

STATUS A or B displays may be called up on the CRT while in the Status mode by pressing the blue keys A or B. STATUS W may be called up by opening any one of the parameter fields (any black button in the left column) and pressing the blue key ENTR.

(2) CLOCK

Open this parameter field by pressing the CLOCK key. The label on this key is colored red. All white keys with red labels beneath the key pertain to this parameter field. You may enter any internal clock interval from 10 ns to 50 ms, in a 1, 2, 5 sequence. Any other entry will cause the ERROR LED to come on when the ENTR key is pressed.

When you key in EXT⌐ or EXT¬ the unit will then allow you to select the sense of the clock qualifier input in this same parameter field. You may select a binary 1, 0 or X (don't care). Use the three black keys so labeled for entry of the clock qualifier.

If you have selected an external clock, and wish to return to the internal clock period previously selected, merely open the CLOCK field, and press the INT key. The unit will revert to the previously programmed internal clock period.

CLOCK QUALIFIER EXPANSION

You may desire to qualify the external clock with more than one bit. The Model 10-TC Probe Pod allows you to expand the qualifier input by as many as 10 bits. Power for the Pod is obtained from the rear panel of the K100-D. For specifc information on this accessory, contact the factory or your local Gould/Biomation representative.

(3) DELAY, (4) DELAY CLOCKS/EVENTS

The K100-D always operates in the Pretrigger Record mode. When you select a trigger delay by clocks, the number of clock periods selected lies between the trigger occurrence and the end of the memory. The default condition is 500 clock periods. Thus, when the instrument detects the trigger event, it will wait 500 more clock periods and then stop recording. Thus, in memory you will have 500 memory cells loaded with prior trigger information, and 500 cells loaded with post-trigger information.

The K100-D has a memory that is 1024 words long. For convenience in setting the unit up, there is a built-in trigger delay of 23 clock periods. Thus, with the trigger delay set to 0, the trigger event will occupy memory location 1000, rather than 1023. See also Figure 3.2.

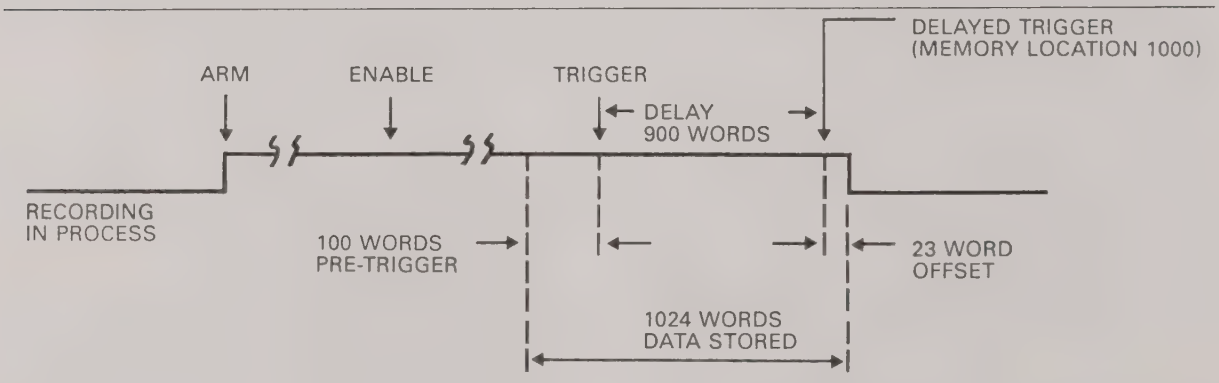


Figure 3.2. Three events, in sequence, are required to complete a recording. The Trigger actually controls the memory contents. The Enable is a qualifying event to allow the instrument to seek the trigger. The Arm event not only begins the recording, but also acts as a precursor of the Enable event. The combination of Enable and Trigger event allow "nested" triggering. For setup convenience, the unit has a trigger offset, or built-in delay, of 23 words. In this example, the trigger delay is 900 words.

The DELAY parameter field is addressed by pressing the black left column key marked DELAY.

You may select trigger delay in terms of trigger events or occurrences. Selection of delay by clocks or event is via switch 4, DELAY CLOCKS/EVENTS. Enter the desired decimal number, and then select delay by clocks or events.

When you select delay by events, the unit will count trigger occurrences and place the nth + 1 trigger occurrence at the center of the memory at location 501. For instance, if you select a delay of 10 events, the unit will place the 11th trigger event at memory location 501.

Trigger delay by events is a helpful mode when you are troubleshooting software in a system. It enables you to capture data on the nth occurrence of a software loop.

The delay field operates only on the Trigger event, and not on the Enable event.

(5) SEQUENCE/POLARITY

This parameter field operates on the display of recorded information and does not affect the recording.

The SEQUENCE portion of the parameter field allows you to rearrange all 16 channels in any desired order. The one restriction in this parameter field is that no channel may be entered more than once. If you do attempt to enter a channel more than once, and press the ENTR key, the ERROR LED will come on, and the underline cursor will move to the second entry of that channel. This allows you to recover easily from an entry error. You can delete the second entry of that particular channel by pressing the SPACE key and then ENTR. If there are several multiple entries, the underline cursor will point them out so that you may remove them.

The Sequence field permits you to format the data in a manner that makes the most sense to your analysis approach. In addition to single keystroke selection of hex, octal, or binary displays when in the Data domain, you can combine data decoding.

The SPCL key causes the unit to observe the channel grouping you have selected as shown in Figure 3.3. Here, the channels have been grouped, with spaces between groupings, to tell the unit how to decode the data. Channels F and E are binary, DCB are octal, A987 are hex, and 6543210 are ASCII.

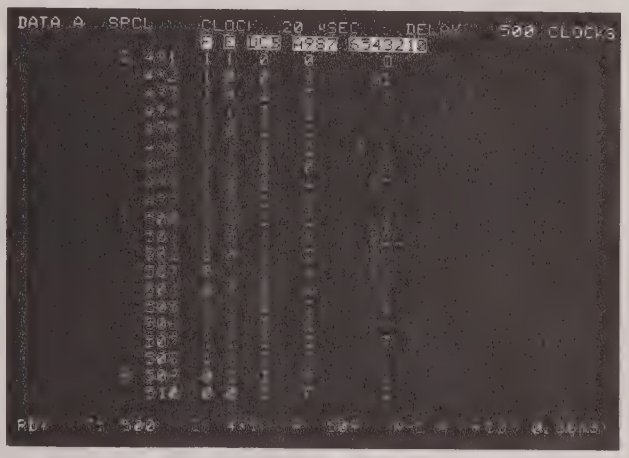


Figure 3.3. Special display mode, where you can format the data decoding in any channel order and any channel grouping to get binary, octal, hex, and/or ASCII.

The full ASCII character set is decoded, including upper and lower case (denoted by brackets) letters, numbers, and all control characters. Those entries in the ASCII string that are not decoded (displayed as seven binary bits) are the characters that are not universally defined.

In the Special Data domain, you can arrange the channels in any desired order, and in any combination of groups.

You may also use the SEQUENCE field to display less than the total number of channels. Placement of the period, or decimal point, anywhere in the SEQUENCE row will delete from display all channels to the right of the period. The double entry rule also applies to the period.

As an example, press the blue key SEQ and, using the Cursor or Reference position keys, place the underline one position to the right of Channel C. Key in a period and press ENTR. The ERROR LED will come on. Note that the underline cursor now position itself to the second entry of the period. Press SPACE and then ENTR. The Status display will be refreshed and show only four channels.

Press the blue key labeled TIMING. Also press the white key labeled X20. Your display should now look like Figure 3.4.

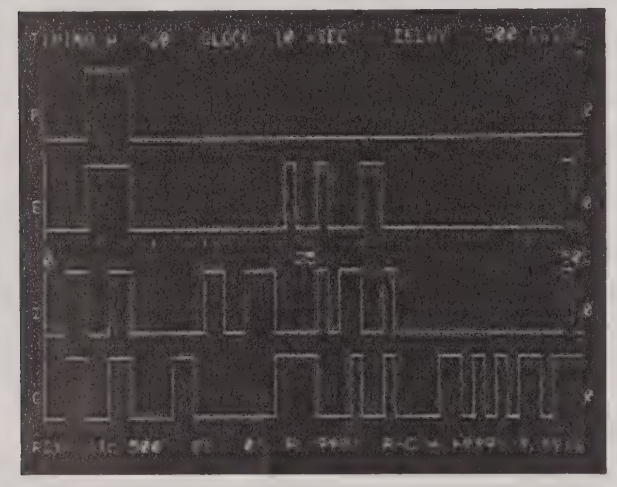


Figure 3.4. Just four channels are displayed, giving an automatic vertical expansion of 4. Times 20 horizontal expansion is also selected.

Notice that only four channels are now displayed, F through C. Also notice that a vertical expansion by a factor of 4 has occurred. This vertical expansion is automatic when four or less channels are displayed. A vertical expansion of X2 occurs whenever 5 to 8 channels are displayed. Also, since you selected a horizontal expansion factor of 20, the data displayed is now only 50 memory cells and gives a very easily examined timing format.

Press X1 and then STATUS. Next press SEQ and place the cursor at the position of the period. Press SPACE and ENTR.

Press TIMING. Your display should now look like Figure 3.5.

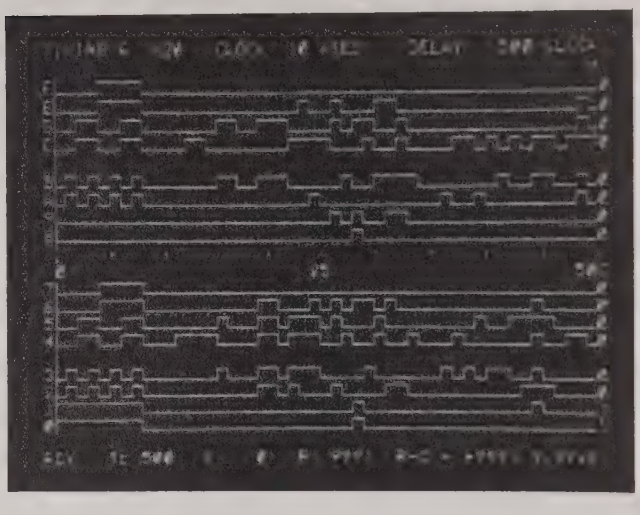


Figure 3.5. Same as Figure 3.3, except that all 16 channels are displayed.

Here we are displaying all 16 channels of information and 50 words of memory.

Press STATUS. The POLARITY portion of the parameter field allows you to select for display, on a per channel basis, either positive or negative convention polarity. This allows you to rearrange the data domain format to allow for any inverted signals in your system. You can enter plus or minus signs by using the black keys labeled +/-.

(6) ENABLE, (7) TRIGGER AUTO/ MANUAL ENABLE

The Enable parameter field allows you to define a 16-bit word, plus two qualifier bits. Once the unit is Armed, it must find the Enable word before it can look for the Trigger word.

The default condition for the Enable word is automatic, as denoted by the A in parentheses. This means that the K100-D bypasses the Enable event and immediately looks for the Trigger.

There are two other conditions for the Enable event. They are manual (M) and combinational (C). These other two conditions are also shown within the parentheses. To define a manual Enable, press down switch 7,

and the M will appear in the parentheses. Note that the unit will not seek a defined Enable word, but will always expect to see a manual Enable, initiated by switch 7.

The act of defining an Enable word changes the letter in parentheses to a C, denoting combinational Enable. This is done by opening the enable parameter field with the enable KEY. You can then key in, using either the three binary keys (black keys labeled 1, 0, X), or key in a hexadecimal word. When you key in a hex word, the unit decodes each hex character (16 white keys) and places four binary bits in the parameter field for each hex character entered.

If you define a combinational Enable for a subsequent measurement, the Enable word selected may not be found by the instrument once you Arm it. In that case, you may press down on switch 7 to manually Enable the unit, and complete the measurement. For the next measurement, the unit will be in the manual Enable mode, and you will have to press switch 7 again. To select a combinational Enable without disturbing the Enable word previously entered, you must reopen the Enable parameter field and enter that Enable word already there. In other words, press ENABLE, then ENTR.

To the left of the Enable word parameter field is a reverse video T. This denotes true or false Enable. When you have selected true Enable, the instrument will seek the Enable word. When it finds a condition where the input signals match the pattern defined, it will have detected the Enable event.

It can also select combinational false Enable. In this mode, the unit will seek the defined Enable event. It will continue to monitor this event until any one of the bits changes states. At that point, it will recognize the Enable event.

To select Enable true or false, open the Enable parameter field by pressing the key ENABLE. The underline cursor will locate itself to the entry for the left most channel; in this case, Channel F. Then use the Cursor or Reference left arrow key to move the underline cursor beneath the T in the field. Then use white key FALSE to change the T to F. To select T, again position underline cursor as before, and press FALSE again.

The qualifiers Q1 and Q2 at the right end of the Enable and Trigger parameter fields can be independently set for both Enable and Trigger Events. When you have entered the LSB for the enable word, in this case Channel 0, the underline cursor will step to the Q1 position. You can then select the states for Q1 and Q2 by using the three binary keys.

QUALIFIER EXPANSION

You may wish to Enable or Trigger from a word wider than 18 bits. You can expand Q1 and Q2, each by a factor of 10, by using the Model 10-TC Probe Pod. Power for the Pod is obtained from the rear panel of the K100-D. For specific information on this accessory, contact the factory of your local Gould/Biomation representative.

(8) TRIGGER, (9) TRIGGER FILTERED/ MANUAL TRIGGER

All the comments that apply to the Enable parameter field also apply to the Trigger field, with the exception that there is no automatic Trigger mode available, just combinational and manual. As before, the letter in parentheses denotes which mode has been selected or used for a given measurement.

(10) THRESHOLD, (11) VAR A, (12) VAR B

This parameter field allows you to independently select a threshold reference level for each channel. You can assign one of four different threshold voltages to any one channel. The black THRESHOLD key opens this field. Notice on the keyboard that the row of four white keys to the right of the THRESHOLD key are those keys used to assign the thresholds. You can select from a preset TTL (+1.4 V), preset ECL (-1.3 V), and two variable thresholds, A and B, that you can specify through the keyboard.

All 16 input channels, plus the qualifier inputs and the external clock and its qualifier may be independently assigned from this list of four different threshold levels.

To specify the variables A and B, you open these parameter fields by pressing the blue SPECIFY key, and then the white VAR A or VAR B key. You can enter a threshold voltage from the keyboard using keys 0 through 9, subject to two restrictions.

1. Voltage entered must lie between -6.4 V and +6.35 V.

2. Voltage can only be specified in 0.05 V increments.

Any entry condition that violates the above rules will cause the ERROR LED to come on.

(13) INPUT MODE

You can select Sample or Latch input modes independently for each channel. This parameter field is addressed via the black key INPUT. Notice, as with the Threshold parameter field, the four keys associated with the Input mode are in the same row with the Input key.

There are two ways of programming the inputs. First, you may go through the parameter field and assign Sample and Latch input modes on a per channel basis by pressing SAMPLE or LATCH keys.

If you wish to assign Sample and Latch input modes on a group basis, you may do so by pressing the 0-7 key and SAMPLE or LATCH keys. This will program channels 0-7 to whatever Input mode you select. The same holds true for channels 8 through F. The K100-D will seek out these channels, no matter where they appear in sequence, and assign them Sample or Latch input modes.

The ability to assign Sample or Latch Input mode on a per channel basis gives you an extra measure of flexibility. For instance, you may wish to ignore any asynchronous glitches (those noise spikes that are not synchronous with a Sample Clock Edge), except on one or two channels. This per channel assignment gives that flexibility.

Refer to Figure 3.6. In the Sample mode, the unit will ignore threshold transitions between active clock edges. This mode finds greatest use when recording in synchronous logic systems. Synchronous logic makes decisions at active system clock edges and is immune to logic changes that occur between these clock edges.

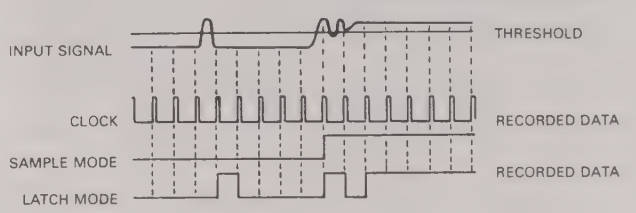


Figure 3.6 Sample and Latch Input modes, and an illustration of how each mode affects the data recorded in memory.

Asynchronous logic is not clocked, and responds to virtually any threshold transition within its speed range even if it is noise. Knowing that narrow noise spikes exist in an asynchronous logic system is of great value.

The Latch mode detects and flags in the analyzer's memory any threshold transitions that occur between the clock edges. The K100-D can detect glitches or noise spikes as narrow as 5 ns, with a voltage overdrive of 25% of total voltage swing; or 250 mV, whichever is greater, even though the shortest clock period is 10 ns.

The sensitivity of the Latch mode is depicted in Figure 3.7. Note that the specification is not stated in terms of absolute voltage levels, but rather a percentage of voltage swing. This is important in those logic systems, namely ECL, where, as the clocking rate of the logic increases, the total voltage swing on either side of the threshold decreases. Thus, the glitch capture capability is in reality only related to percentage of voltage overdrive rather than a finite voltage swing.

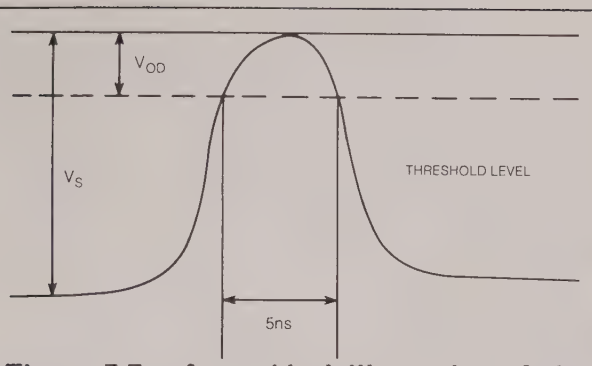


Figure 3.7. A graphical illustration of the Latch mode specification, which is related to percent voltage overdrive rather than a finite overdrive. VOD is 25% of VS. The same is true for negative-going glitches.

Noise spikes between clock edges are flagged in memory as pulses represented as being one clock interval wide, opposite in state to the previously clocked state. Figure 3.5 illustrates the treatment of an input signal, with both the Sample and Latch modes, and what effect these input modes have on the actual recorded information.

The Latch mode indicates the presence of noise spikes, or glitches, and their time occurrence relative to the other recorded information. The period of the noise spike is not indicated by the Latch mode flag; the measurement of the glitch is limited to the time value of one memory cell.

Even though you cannot measure the actual width of the glitch, its presence is recorded, and this gives you very definite information for diagnosing a problem in your system.

(14) (SEARCH)

This parameter field operates on the Data domain display. When in Status display mode, open this parameter field by using the blue SEARCH key. This allows you to specify, in binary or hexadecimal, a word that you wish to find in the Data domain display. The word need not be known to exist in the memory. The analyzer will find that word for you if it exists.

Using the data automatically stored in memory upon power up, let's use this mode to search for a word. In the Status display, open the Search parameter field by pressing the SEARCH key. Then key in hexadecimal 1010, and press the ENTR key.

Press the blue key DATA. Your display will look like Figure 3.8.

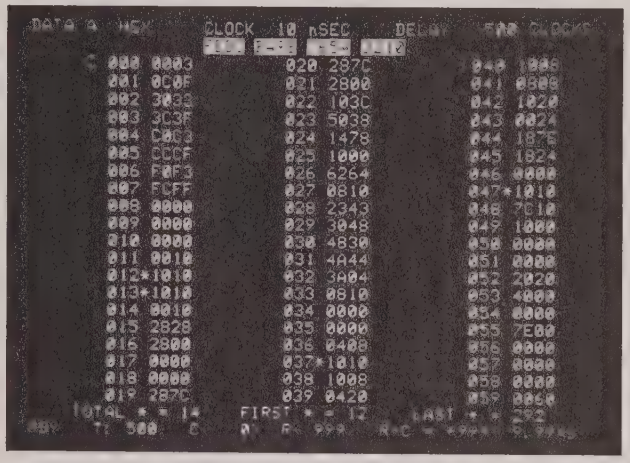


Figure 3.8. Here the unit has been programmed to search for the hex word 1010. It found this word 14 times; first occurrence at memory location 12, and last one at 292. This information is read out at the bottom of the screen. Each occurrence is marked by an asterisk.

Note that there are 14 occasions where the hex words 1010 occurred. These occurrences are marked by asterisks, and the total number of occurrences is tallied along with the first and last occurrences of that word. If your display does not look like Figure 3.8, go back and execute the above routine.

To look at the last occurrence of 1010, for instance, you can specify Cursor position as follows without scrolling through the memory. Press SPECIFY and either Cursor arrow key. At the CRT bottom, the Cursor parameter field will be in reverse video. Key in 292 and press ENTR. The Cursor will reposition itself to memory location 292, the last time 1010 occurred. The Reference position can also be specified in this fashion.

The Search mode allows you to spotlight a particular address in a loop, for instance,

so that you may be able to visualize in the data domain the structure of that loop. Notice that you need not specify a state for every channel; for instance, if you wish to find those occasions in memory when the first four channels assume a particular combination of states, you may key in the desired states for the first four channels only, and leave the other channels in "don't care" positions. Then the instrument will search for those occasions where the first four channels occupied the desired states. This gives you the flexibility of finding in memory only those states that you wish to locate.

(15) ARM MODE

You can select either Auto Arm or Manual Arm with switch 16. In Manual Arm mode, the instrument makes a measurement after you have manually armed it with switch 16. It completely executes the measurement and returns to a ready for arm state, as denoted by entry 18 RDY. If you push up on switch 16, the instrument then automatically arms itself upon completion of each measurement. Because of internal housekeeping, the maximum rate at which the instrument can arm itself, and detect Enable and Trigger events, is on the order of 10 times per second.

Usually, you use the manual Arm mode when you wish to directly control the measurement process. Use of the auto Arm mode is generally in those cases where you wish to observe continuous updates of the operation of your circuit.

The Arm function controls the Compare mode of the instrument. This is a mode in which you can store in a reference memory a sequence of events from your system. This may be, for instance, a correct sequence of events against which you wish to compare an incorrect sequence of events. Specifically, this could be a situation where you have a system that randomly malfunctions. By the nature of the malfunction, or symptoms of it, you can usually narrow down on a certain portion of the system program within which the malfunction occurs. This series of program steps can be recorded and stored in the Reference memory, B. The instrument can then be put into a mode where it will continually monitor that flow of program executions, make a measurement each time, and compare that captured data with the reference. Once it finds a difference between the two memories, it will halt on that occurrence and save the incorrect sequence of program steps. The instrument can do this in the automatic and unattended mode; therefore, you can allow it to monitor your system for any length of time and be sure that the malfunctioning sequence will be captured and displayed.

The manner in which the instrument does this is via the Compare mode. Figure 3.9 is

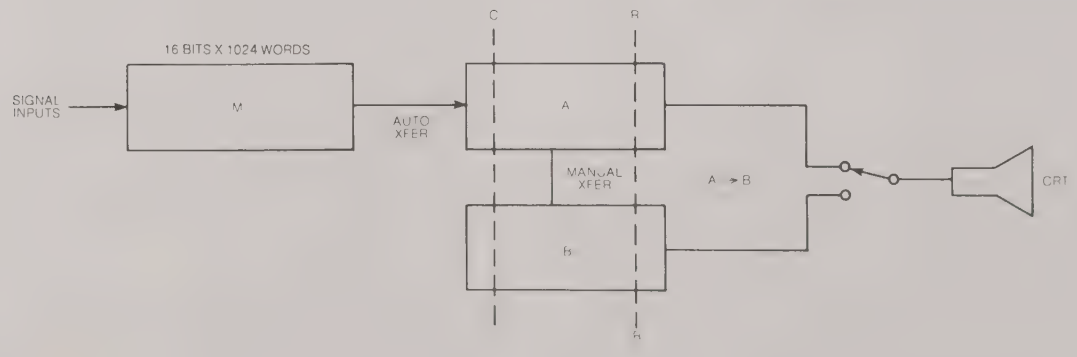


Figure 3.9 Record (M) and display/compare (A and B) memory structure inside the K100-D.

a block diagram of the memory structure of the K100-D. The memory M receives the signal inputs at real time rates; M is the memory that operates at 100 MHz. Once the memory has been filled with data, this data is then automatically transferred to the A memory, and then will be displayed on the CRT.

In addition, you can manually transfer using the A→B key, the contents of A into memory B. By doing so, you have created in B a reference memory of up to 1024 program steps, against which the instrument will automatically compare the contents of A. Manual comparison between two subsequent measurements can also be compared.

The steps to follow for the use of this feature are as follows.

The use of the Auto Stop Compare mode depends upon measurements made with respect to some system clock (synchronous recording) and some specific trigger event. If the comparison is made with respect to data stored using the internal clock of the K100-D (asynchronous recording), a valid comparison cannot be made because of the asynchronous nature of the measurement; i.e., the two compare recordings can differ by one clock period, thus making comparisons invalid.

1. Select from your system operation a sequence of events that you will use as a reference, and record this sequence in the instrument. Use manual Arm mode, rather than Auto, at this point.

2. Transfer the contents of the A memory into memory B by using the blue key A→B.

3. Call up Auto Stop mode by using the blue key AUTO STOP. The Arm mode parameter field will change from MANUAL to AUTO.

4. Select the condition for comparison, either A=B (black key) or A≠B (white key). Arm mode field will now read AUTO STOP, A=B or A≠B.

You have control of the interval over which the comparison will be made. You can place the Cursor and Reference anywhere within the 1024 word memory to specify a sequence of memory locations for comparison. For instance, in Figure 3.7 if you invoke the limits on the comparison, the actual comparison interval between the two memories would be memory locations 491 through 509 inclusive.

To tell the K100-D to observe the limits imposed by the Cursor and Reference positions in the Status display mode, after specifying Auto Stop, A=B or A≠B, press the blue key (LIMITS). The display will now read AUTO STOP <A=B> .

5. Without changing any recording parameter fields, press switch 16 up. This initiates the sequence of making a measurement and then comparing that measurement with the stored reference. When the unit is in the Auto Stop mode, it will not update the display memory until it finds a block of data that meets the selected condition. At that point, the A memory will be updated with the just trapped and compared data. This allows the unit to detect triggers at rates up to about 8 per second.

6. The Status byte in the lower left corner, entry 18, will be blinking through its routine. When the instrument display is a steady RDY indication, it means that the selected condition has been met. The unit is now standing by with information in the A memory that compares, or does not compare, with the reference.

To view the two memories, press the blue key DATA, and the blue key A/B. Now the instrument will alternately display the information from the A and B memories. By moving the Cursor through the memory, you may view those selected portions.

To initiate another round of compari-

sons, merely press switch 16 up. This will cause the instrument to go through measurement and compare cycles until the selected condition is met. Before initiating the Auto Stop cycle again, place the instrument back into the Status Display mode so that you can achieve the maximum throughput rate.

(17) FILTER

This parameter field is selected by pressing switch 9 up. Any number between 1 and E (14) may be entered in this field. The K100-D will then test any input bit patterns that match the specified Enable and Trigger events. Any bit pattern must match for a minimum of record clock sample periods. For instance, if you enter the number 5, the K100-D will test the Enable and Trigger events to insure that these events are valid for a minimum of 5 clock periods. On the Time or Data displays, notice that the Trigger event is labeled not at the first period that it matches the trigger combination, but after the number of clock periods specified by the trigger filter.

The filter will always reject events when the event time duration T meets the following: $T \leq (F-1)$ (CLK INTERVAL) -3 ns, where F = Filter setting. The Filter will always accept events that meet the following: $T \geq F$ (CLK INTERVAL) +4 ns.

(18) RDY, CK?, EN?, TG?, DLY, BSY

The Status byte is displayed in the lower left-hand corner of the Status, Time and Data Domain displays. Below is a tabulation of the meaning of each one of these bytes, in the order in which they are displayed.

RDY — The unit is ready for an Arm event. The only time you will see this displayed is when you are in manual Arm mode. If you have Armed the instrument and wish to get it back into a ready for arm status, press button 16 down a second time. This will cancel the measurement that you called for.

CK? — When you are operating the instrument with an external clock from your system, and the clock is not active in your system (or the clock qualifier bit is in the opposite state of that specified) the instrument will respond by asking for a clock. This will occur only when trigger holdoff is operational.

When you are operating on internal clock, and this message is displayed, it means that the instrument is executing a trigger holdoff and is flushing its memory of any old data that exists. During this time it will not recognize Enable or Trigger events. The clearing of the record memory occurs at the record clock rate, so that if you're operating at clock intervals considerably shorter than 1 ms, you will not see this message.

CK? will only be displayed under the above conditions. It will NOT be seen after the trigger holdoff period if the clock is halted.

EN? — The unit is waiting to receive or detect an Enable event. If you have it programmed for a combinational Enable event, it means that the instrument has not yet detected it. If you have it programmed for manual, it is asking you to press down switch 7.

TG? — The unit is waiting for a Trigger event. It has not yet detected it or is waiting for you to manually trigger it via switch 9.

DLY — The unit is counting down the trigger delay, either in terms of clock periods or trigger events. When delay is no longer displayed, it means that the recording has been completed, and the following message will appear.

BSY — The unit has completed the measurement and is now updating its display memory. The unit will not record any information during this period of time.

(19) Input A, Input B

These connectors are labeled so that you can match up the labeled probe assemblies to the proper connector. The only difference between the two probe assemblies supplied is the shrink sleeve label at the end of each probe wire. Otherwise, the probe assemblies are identical.

Figure 3.10 shows a representative probe podlet along with its supplied accessories: one each red and black short flying leads, and two spring loaded hook tips. The BNC adapter shown is an accessory available from the factory.

This BNC adapter allows for easy conversion of any probe podlet to a female BNC for convenient connection of the Model 10-TC Probe Pod. This pod may be used for extending the combinational Trigger word (or Enable word) out to the maximum of 36 bits.

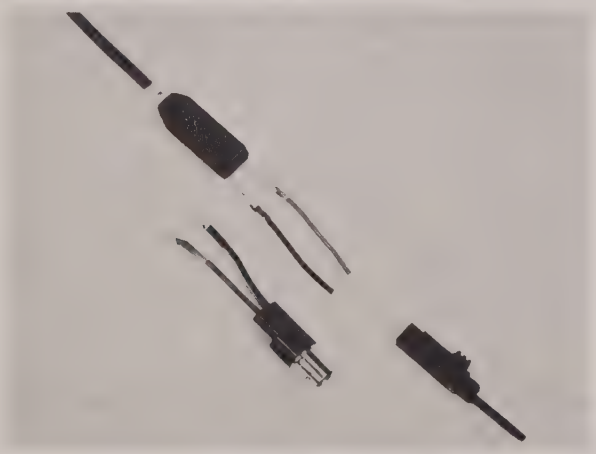


Figure 3.10. Channel F probe podlet. The flying leads and spring loaded hook tip are supplied with the instrument, along with the probe assemblies. The BNC adapter shown is an accessory.

Each 10-TC can detect up to a 10-bit word. By connecting two 10-TCs to Q1 and Q2 respectively, you are then able to AND together the 16 bits of the trigger word with the two qualifier inputs, which gives you a total of 36 bits for a trigger. The trigger output on the 10-TC is via coax cable and a BNC connector. Thus, the adapter shown provides an interface between the trigger qualifier input and the trigger output cable of the 10-TC.

In like manner, you can expand the clock qualifier CQ. Thus, you can qualify an external clock with up to 10 bits from your system.

PROBE INPUTS

Each probe assembly consists of 10 podlets; each podlet contains a hybrid active circuit. All 20 podlets are identical electrically. Each podlet provides a 1 MΩ , 5 pF input impedance provided by the buffering amplifier in the hybrid circuit. The circuit also provides threshold detection, and converts this discriminated signal to a differential ECL signal, which drives the flat ribbon cable back to the instrument. Thus, your system only sees the input circuitry of the podlet, and not the flat ribbon cable.

The length of the short flexible leads has been selected for a maximum length that will not degrade the high performance of the instrument.

Attaching flexible leads of a length longer than those supplied will cause degradation in performance. However, if you wish to use flexible leads of a length longer than that supplied, you may purchase from the factory a connector kit containing both connectors used on the flexible wire. From this you may fabricate any special wire lead assemblies that you desire for connection to your system.

Notice that the female socket that mates with the spring loaded hook tip kit is designed to mate with a 0.025 inch square post. Even though these female connectors were chosen for their rugged design, damage may result in forcing them over posts of larger size. The result will be that if you subsequently mate this socket to the hook tip, the integrity of the connection will be lost. This is an Augat receptacle, part number LSG-2BG2-1.

The female connector at the other end of the wire lead is a snap fit into the male pin recessed into the podlet. This means interconnection to your system is a very good compromise between ruggedness and miniaturization. This is an AMP receptacle, part number 60789-3.

Available also from the factory is a repair kit for each individual podlet, in case of physical damage to the active circuitry. For details on any of the above mentioned accessories, please contact us at the factory or your local Biomation representative.

EXTERNAL CLOCK AND CLOCK QUALIFIER INPUTS

The K100-D can accept your system clock at rates between DC and 70 MHz. The minimum clock pulse width shall be 5 ns. The setup time requires that the data be present and settled out 2 ns before the active clock edge. Likewise, the hold time requires that the data must stay settled for 2 ns after the active clock edge.

When you input a qualifier signal on CQ, it must go TRUE a minimum of 12 ns before the clock goes TRUE, and go FALSE a minimum of 1 ns after the clock goes TRUE. Also, the qualifier must go FALSE a minimum of 10 ns before the clock goes FALSE. See Figure 3.11.

These timing requirements are necessary to ensure that no false clocks are generated due to signal edge overlap. The requirements are such as to limit the qualified clock rate to a maximum of approximately 40 MHz.

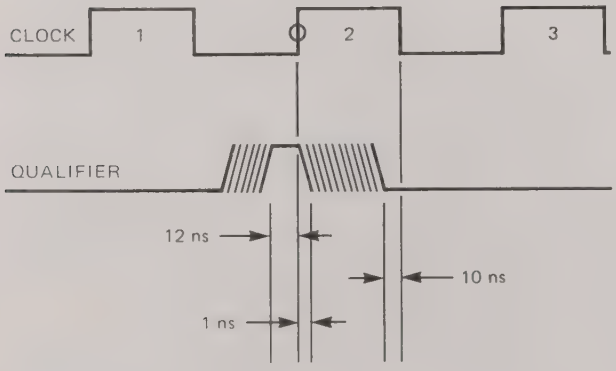


Figure 3.11. To qualify clock pulse 2, the minimum timing requirements for the qualifier are as shown.

(20) M→A

During normal K100-D operation, the unit completes a measurement, transfers the data from the record (M) memory to the display memory (A), and puts the data on the CRT. A complete measurement requires that a record clock be present for the duration of the measurement, including Enable, Trigger, and Trigger delay. See Figures 3.2 and 3.9.

In some cases when using an external clock, the clock may cease activity before the measurement has been completed. This may be due to a normal system function or a failure. When this occurs, the data existing in M may still be of interest for analysis.

The M→A key allows you to transfer the contents of M into A for display. You can record a short burst of data, press M→A, and view it. You can record and display a second burst in the same fashion. The second burst will be displayed following the first, provided the total number of clocks received during the two bursts is less than 1024. This preserves all of both bursts in memory.

3.3 Rear Panel Inputs and Outputs

Refer to Figure 3.1 while reviewing this section.

(1) TRIG

This signal is TTL active low. It goes low as soon as the instrument detects the trigger event selected. The signal stays low for the entire period of time that the trigger event is valid. This signal is synchronous with the input data.

(2) SPARE BNC CONNECTORS

(3 VIDEO

This is a composite video output with an amplitude of 1 V peak-to-peak into a 75 Ω load. With this output you can drive a large raster scan CRT display for viewing by several people.

(4) LEMO POWER CONNECTORS

These outputs provide power for two 10-TC probe pods, or for various signal input adapters. Minimum available power is +5 V at 1.1 A, -5.2 V at 0.3 A.

(5) DIGITAL INTERFACE CONNECTOR

This connector is used for digital I/O in the IEEE 488-1975 format, if the instrument is so equipped.

Refer to the appropriate operating manual supplement that describes this digital interface and the I/O software.

(6) LINE VOLTAGE SELECTOR, (7) FUSE

The K100-D may be used on a wide range of power line voltages at frequencies of 50 or 60 Hz nominal. The rear panel contains a fuse holder and a pair of slide switches for selection of nominal power line voltages. Table 3.1 shows these voltages, switch positions, and fuse selection required for that power line voltage. The selected switch positions are referred to as left and right when viewed facing the rear panel.

Table 3.1

Range (+10%)	Selector Switch Positions	Fuse-Amp (Slow Blow 3AG)
100	Both in	5
120	Left in, right out	5
220	Left out, right in	2.5
240	Left out, right out	2.5

Figure 2.2 shows the placement of a jumper on the MPU PC board for 50 Hz operation of the display. You may have to adjust the horizontal oscillator frquency control, R2, for 50 Hz operation. See Appendix A for display control layout.

(8) POWER INPUT CONNECTOR

Connect the line cord to this connector, using a three-wire grounding type plug for connection to line power.

3.4 Set-up Procedure and Operation

The purpose of this section is to offer the K100-D user several operating examples that he may duplicate in his facility. The examples are designed to increase user understanding and familiarity with the K100-D. The examples highlight recording in the self-programmed mode (default); recording using a 50 ns clock period; recording with 200 words of pretrigger and 800 words of post-trigger information; and recording with a user-selected event delay of four.

The data source selected for the following examples is a pulse generator that has a manual, single pulse output mode. The high and low levels of the pulse output should be adjusted for TTL compatibility. A "1" = 2.4 V and a "0" = 0.4 V. The width of the pulse should be 1.0 μs. Again the generator should be in the manual, single pulse output mode.

3.4.1 Self-Programmed Recording

The K100-D has a self-programmed mode of operation that was designed to enhance its self-teaching ability. This first recording will be made with all the status parameters programmed exactly as they are immediately after power up. Turn the power off, wait 1 minute and turn the power back on. The K100-D's status display will look exactly like the one shown in Figure 3.1.

Connect the signal generator's output and ground to their corresponding points on probe zero of the K100-D. The status display indicates that this recording will be at the K100-D's maximum recording rate and that half of the unit's memory will be allocated to pretrigger and the other half to post-trigger recording. The Enable and Trigger channel are zero; however, the Enable word has been defeated by being placed in the auto mode. All thresholds have been set at TTL, which is compatible with the signal generator's output. The Arm mode is auto, but becomes manual the first time the K100-D is manually Armed.

Manually Arm the K100-D and the unit begins recording. Note that the record status (lower left corner of the CRT) reads TG?, indicating the trigger word has not been de-

tected. Manually pulse the generator. The record status indicator will read RDY. Press the blue TIMING button in the Display button group. The timing display will be exactly like Figure 3.12.

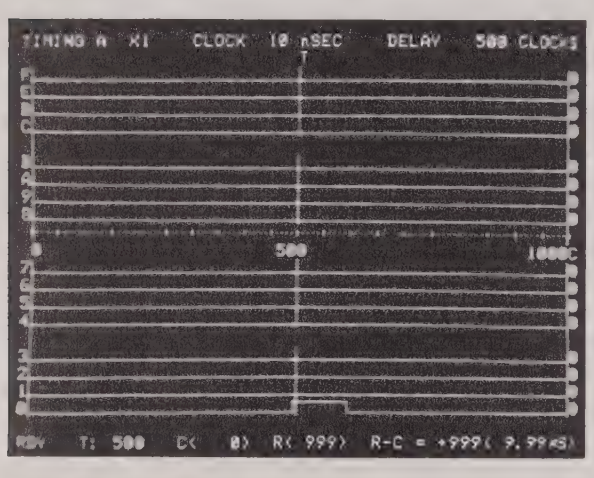


Figure 3.12. A self-programmed recording by the K100-D of a 1 μs pulse.

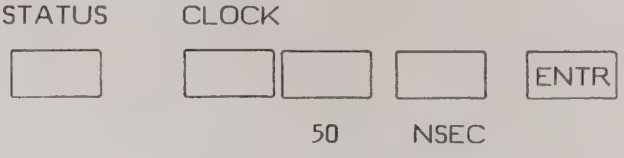
In this recording it is important to note that the trigger point is exactly in the center of the memory as dictated by the delay of 500 clocks, and the 1 μs pulse has been sampled 100 times as a result of the high clock rate (100 MHz or 10 ns/sample) of the K100-D.

The number of times that the K100-D has sampled the pulse can be determined by moving the C Cursor to the rising edge of the pulse and the reference cursor to the right edge of the pulse. The word difference and time difference between the two cursors is found at the lower right corner of the display, R-C. The number in front of the parenthesis represents the number of memory cells the 1 μs pulse occupies. The number inside the parenthesis is the period of the pulse. These numbers should be +100 and 1.0 μs, respectively, contingent upon how accurately the period of the generator pulse was set.

Please recall that all logic analyzers are sampling devices and this was an asynchronous recording. That is, the logic analyzer's sampling clock has no fixed phase relationship to the pulse output. If this example recording is repeated several times, a ± 1 word variation will be noted in the word difference indicator. The time difference indicator will also reflect this variation. These variations are inherent in asynchronous recordings.

3.4.2 A User Programmed Recording Using a 50 ns Clock

To program the K100-D's clock for the next recording, the following keystrokes are necessary.



The new status, STATUS W, will look exactly like Figure 3.13.

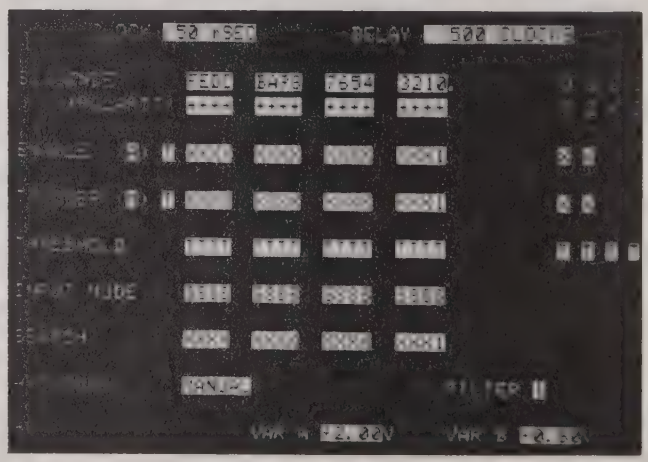


Figure 3.13. Status W reflects the fact that the clock period has been changed to 50 ns.

Manually arm the K100-D; the record status will read TG? Manually pulse the generator. The record status indicator will read RDY. Depress the blue TIMING button. Your display will be a duplicate of Figure 3.14. Note the left and right cursors in this figure reflect the suggested pulse measurement of the previous example.

Note that the pulse period appears shorter even though the pulse is the same period.

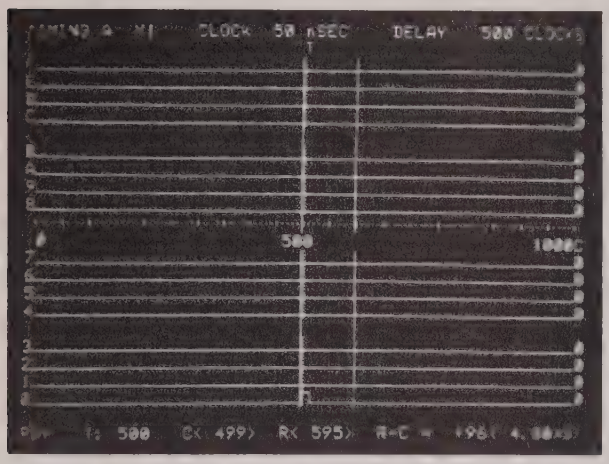


Figure 3.14. A 1 μs pulse recorded using a 50 ns clock period.

The changing of the clock sample period has increased the amount of time recorded and displayed on the CRT by a factor of 5. This dwarfs the 1 μs pulse. Using the K100-D's cursors, horizontal expansion and word difference/time difference indicators, verify that the pulse's period is 1 μs. Remember that when operating in a horizontal expansion of X5, X10, or X20, the data to the right of the C cursor is expanded. Figure 3.15 measures the 1 μs pulse using a X20 horizontal expansion.

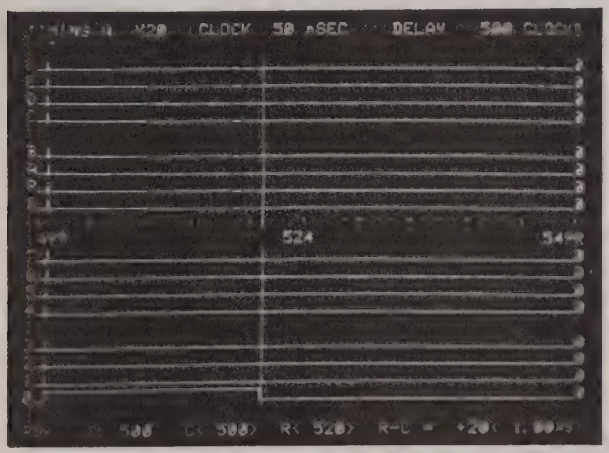


Figure 3.15. This 1 μs pulse is being measured using both cursors and a horizontal expansion of X20.

3.4.3 A User Programmed Recording With 200 Words of Pretrigger and 800 Words of Post-Trigger Data

To make a recording with the memory allocations indicated in the title, the following keystrokes are necessary.

STATUS DELAY

[ ] [ ] [8] [0] [0] [ENTR]

Arm the K100-D and manually pulse the generator. After pressing the TIMING button the display should look exactly like Figure 3.16 when viewed with a X1 horizontal expansion.

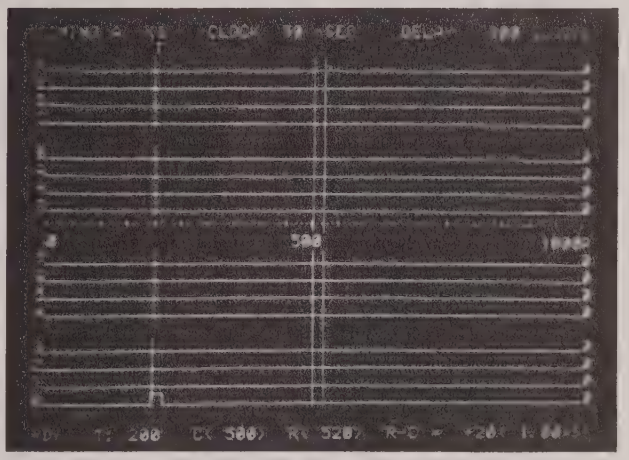


Figure 3.16. This figure demonstrates a recording where 200 words of Pretrigger and 800 words of post-trigger information have been saved.

Note that Delay positions the K100-D's 1024 word recording relative to the Trigger. In the first two examples, the Delay was set for 500 words resulting in half of memory being allocated to pretrigger and the other half to post-trigger recording. This last example has changed the memory allocation to 20% pretrigger and 80% post trigger

This information may be viewed in the data domain by pressing the DATA button, then the BIN button. This will give you a Binary display of the recorded information. To view channel zero changing from a logic

"0" to "1", address the C cursor to memory position 199 as follows.

SPECIFY LEFT CURSOR

Moving the cursor has allowed the user to view channel 0 changing to a logic "1" at K100-D memory cell 200.

Figure 3.17 illustrates the resultant CRT display. Other decode formats may be used by depressing the desired decode base buttons to the left of the DATA button.

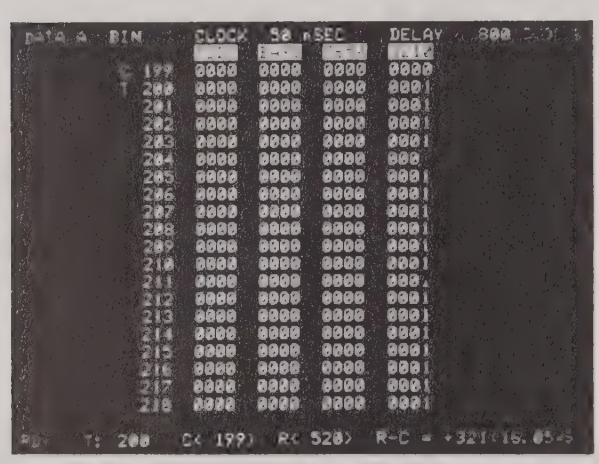
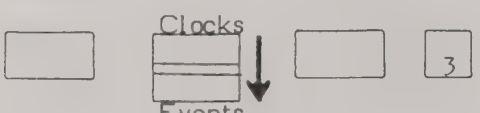


Figure 3.17 A BINARY decode of the data recorded at the trigger point.

3.4.4 A User Programmable Recording with an Event Delay of Four

To program the K100-D for a four event delay recording, the following changes to the status must be made. Make these changes with the following keystrokes. Please pay special attention to the DELAY switch manipulations; this will change the K100-D from Clock to Event delay.

STATUS DELAY DELAY



ENTR

The K100-D is now programmed for a event delay recording of 4. Recall that the K100-D's formula for event delay is N (user selectable) +1. The K100-D adds 1 event of static delay in addition to the user-selected amount, giving an event delay of four.

Manually ARM the K100-D and manually pulse the signal generator four times. The K100-D will record the data about the fourth occurrence of the "0" to "1" trigger on channel 0. The exact data recording allocation about the fourth trigger is:

500 words of pretrigger information, and

523 words of post-trigger information including the trigger word.

The fourth trigger will be in memory cell 501. This can be verified by pressing the DATA button and moving the C cursor to the 500 memory cell. See Figure 3.18.

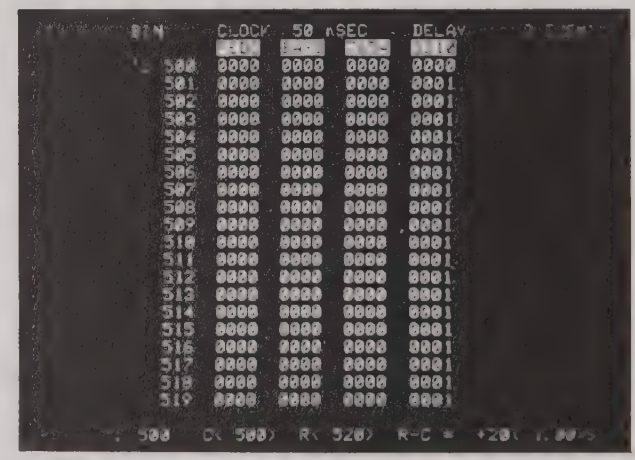
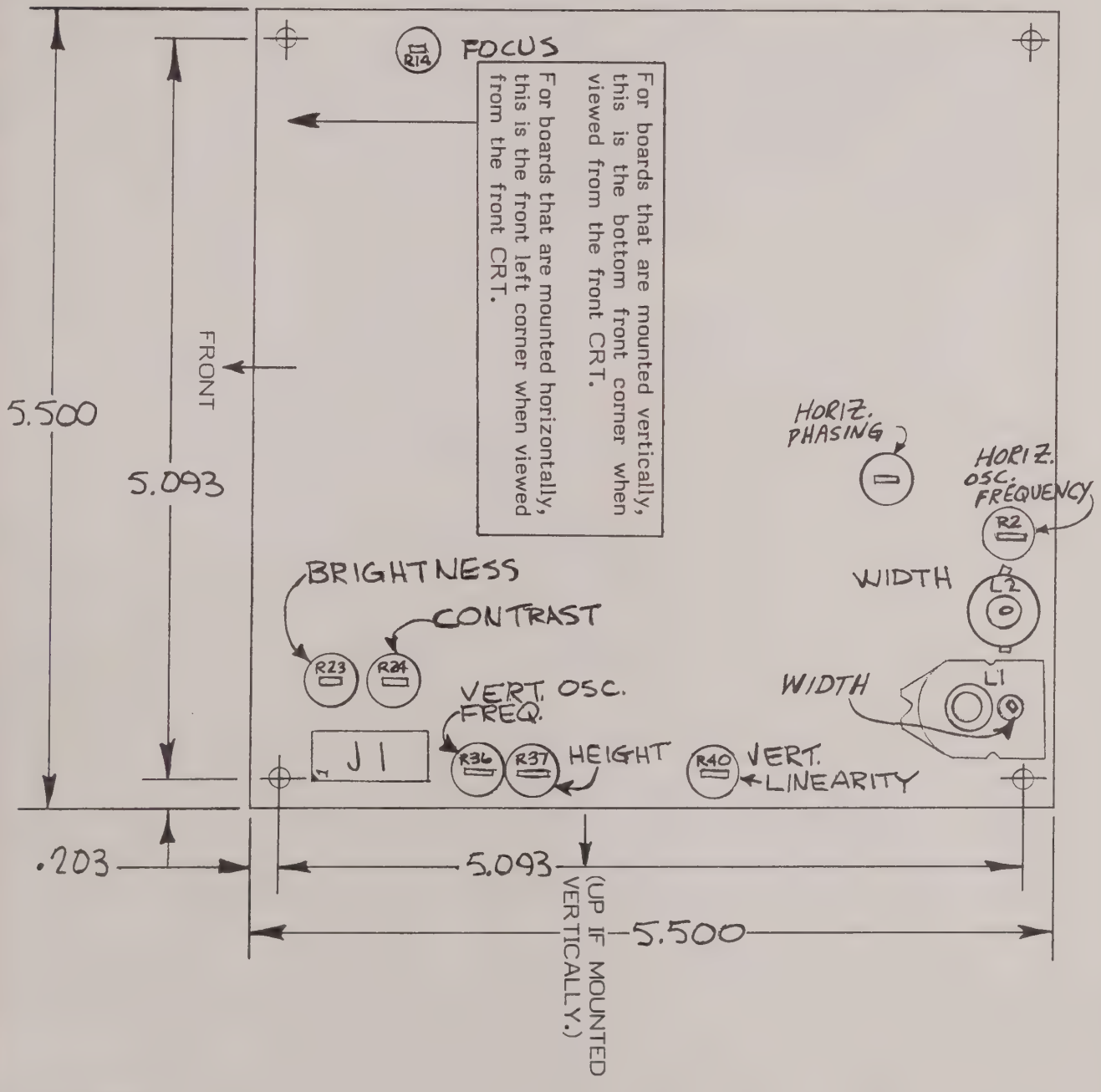


Figure 3.18. This Event delay recording of four allows the user to view 500 words of pretrigger and 523 words of post-trigger information.

User-generated variations on the examples given will further your understanding of the K100-D.

APPENDIX A

CRT DISPLAY CONTROL LAYOUT



CAUTION:

Extreme care must be used in servicing this unit because of **HIGH VOLTAGE.** Failure to take proper precaution could result in electrical shock that could be fatal or cause bodily injury.

APPENDIX B

K100 DIAGNOSTIC ROUTINE

The following is an explanation of the diagnostic routine used for the self-test feature of the K100-D. By a combination of manual and automatic tests performed on the instrument, you will be able to isolate the problem down to the component level. Since this is a preliminary manual, it contains no schematics. If you should get an indication of a failure during the execution of this diagnostic routine, please contact the Customer Service Department at the factory, or your local representative, for assistance.

The K100-D diagnostic routine performs the following checks every time the power is turned on.

1. All keys and switches on the front panel, except AC POWER, are checked for a "not pressed" condition. If any key or switch is pressed or shorted, an error indication is given.

2. All 32,768 bytes of microprocessor RAM are checked by writing and reading data to and from every bit. If any failure is detected, an error indication is given.

3. All 24,576 bytes of microprocessor ROM are checked. A parity byte is generated for each ROM when the ROM is "burnt." The parity value is generated again by the diagnostic routine and compared to the original parity byte. If there is a difference, an error indication is given.

4. All 1024 words of high speed record memory are checked by writing and reading data to and from every bit. If any failure is detected, an error indication is given.

If no errors are discovered by the diagnostic routine, the following occurs:

1. As soon as the AC POWER switch is turned on, the ERROR LED at the top of the keyboard will light. The CRT will display a random pattern. (If the K100-D is "cold" when power is turned on, nothing will be displayed until the CRT warms up. This usually takes longer than it takes to execute the diagnostic routine. In this case, steps 1 through 5 will not be seen on the CRT.)

2. The CRT will be erased (i.e., the screen will be dark).

3. The CRT will have an all bright display.

4. The CRT will display alternating black and white vertical lines.

5. The vertical lines will shift slightly. By the end of this step, about 4 s will have gone by since the power was turned on.

6. After about 13 s from power on, the ERROR light will go off and the STATUS display will appear on the CRT. The message "POWER UP COMPLETE" will be in the upper left corner of the screen.

If an error has occurred, an error indication will be given. The following is a list of the error indications that can occur and the associated error description.

ERROR INDICATION	ERROR DESCRIPTION
The ERROR LED is still on at least 20 s after power is turned on. It is NOT blinking.	The microprocessor has failed to reset and/or cannot run properly. No operation of the K100-D is possible.
The ERROR LED starts to blink as soon as power is turned on. Pressing only the black "X" key for at least 1 s does NOT stop the blinking.	One or more keys or switches are pressed or shorted. The key or switch must be released or the short must be cleared before any further operation of the K100-D is possible. NOTE: The operator of the K100-D may check to see that a particular key or switch makes contact by doing the following procedure. 1. Turn the power off. 2. Press the key or switch. (If a switch under the CRT is being checked, it should be held either up or down.) 3. Without releasing the key or switch, turn the power on. The ERROR LED should immediately start to blink and should continue to blink as long as the key or switch is pressed. 4. As soon as the key or switch is released, the ERROR LED should return to a steady on state. The remaining diagnostics will run and if everything else is okay, normal operation will begin.
The ERROR LED starts to blink within about 6 s after power is on. Pressing only the black "X" key for at least 1 s turns the ERROR LED off for as long as the key is pressed.	An error has been detected in either ROM or RAM of the microprocessor. To determine which part of ROM or RAM has the error, do the following. 1. Press the black "1" and the black "0" keys down, one key at a time. Hold the key pressed for at least 1 s. Do not press any other key or switch. One of these keys will turn the ERROR LED off for as long as the key is pressed. The other key will have no

affect on the ERROR LED. If the "1" key turns the ERROR light off, the error is in ROM. If the "0" key turns the ERROR light off, the error is in RAM.

2. Press the white keys one key at a time. Hold the key pressed for at least 1 s. Do not press any other key or switch. One of these keys will turn the ERROR light off for as long as the key is pressed. The other keys will have no affect on the ERROR light. Note the number or letter of the key that turns the ERROR light off. If the error is a ROM error, do steps 3 and 5. If the error is a RAM error, do steps 4 and 5.

3. Find the ROM on the microprocessor PC board that has the same number or letter that you discovered in step 2. (The number or letter will be on the PC board immediately above the ROM.) That will be the ROM in error.

4. The table below gives the relationship between the number or letter of the key that turns off the ERROR light and the code for the defective RAM.

Key	RAM Code
0	B1
1	B2
2	B3
3	B4
4	B5
5	B6
6	B7
7	B8

ERROR INDICATION	ERROR DESCRIPTION

ERROR INDICATION

```
        HIGH SPEED RECORD MEMORY ERRORS

                        BIT PATTERN
ADDRESS/PHASE    FEDC   BA98   7654   3210
      1/2        0100   1100   0111   0000 WRITTEN
                 0100   1100   1111   0000 READ
      2/3        1111   0000   0111   1100 WRITTEN
                 1111   0000   1111   1100 READ
      5/2        1111   1111   0110   1001 WRITTEN
                 1111   1111   1110   1011 READ
      6/3        0100   1100   0111   0000 WRITTEN
                 0100   1100   1111   0000 READ
      7/4        1111   0000   0111   1100 WRITTEN
                 1111   0000   1111   1100 READ
     10/3        1111   1111   0110   1001 WRITTEN
                 1111   1111   1110   1011 READ
     11/4        0100   1100   0111   0000 WRITTEN
                 0100   1100   1111   0000 READ
     12/1        1111   0000   0111   1100 WRITTEN
                 1111   0000   1111   1100 READ
     15/4        1111   1111   0110   1001 WRITTEN
                 1111   1111   1110   1011 READ
MORE THAN 9 ERRORS
PRESS "CE" KEY TO CONTINUE
```

Figure B-1

ERROR DESCRIPTION

3. BIT PATTERN WRITTEN - The bit pattern that was written to high speed record memory. Each bit corresponds to a particular channel (0 through 9 and A through F). The channel ID appears as a column heading on the display.

4. BIT PATTERN READ - The bit pattern that was read back from high-speed record memory.

Any difference between what was written and what was read is an error. Up to nine addresses with one or more bit errors will be displayed on the CRT. Usually, when a particular chip is bad, all addresses will have the same phase number and all addresses will have the same channel bit wrong. Refer to the record memory board schematic to locate the bad chip. If more than one phase is wrong or more than one channel bit is wrong, the error is usually a shorted trace or other PC board error. Other kinds of errors can cause these same indications.

The operator may attempt to bypass errors in high speed record memory by pressing the CE key for at least 1 s. The K100-D will go to the STATUS display. The message "ERROR IN POWER UP" will be in the upper left corner of the screen.

Note that the K100-D may not function properly if an error is bypassed in this way.

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